WORKER EXPOSURE TO MALATHION, SULFUR AND NUISANCE DUST DURING DATE HARVEST

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SUMMARY

In November 1987, the Worker Health and Safety Branch staff was asked to investigate complaints from date harvesters in Coachella Valley. Workers were concerned that various systemic effects such as mild nausea and eye and skin irritations were being caused by exposure to pesticides on the dust generated by harvest activity. Malathion and sulfur, the only pesticides registered for use on dates, were applied throughout the growing season. Total and respirable airborne dust levels, as well as measurements of total and respirable malathion, malathion oxon, and sulfur levels were collected from the breathing zone of five harvesters. Hand and face washes were done at the end of each monitoring period to estimate the amount and composition of dust on these surfaces. Total dust samples ranged from none detected (ND) to 1.96 milligrams per cubic meter (mg/m^3) in the respirable particulate sample, and from 6.50 to 36.99 mg/m^3 in the total particulate sample. Malathion was present in small amounts in the breathing zone samples, ND to 0.04 mg/m^3 in the respirable particulate sample and 0.05 to 0.24 mg/m^3 in the total particulate sample. Malathion oxon levels ranged from ND to 0.01 mg/m^3 in the respirable sample, and from ND to 0.04 mg/m^3 in the total sample. Sulfur levels ranged from 0.29 to 2.20 mg/m^3 in the respirable sample, and from 5.65 to 24.98 mg/m^3 in the total sample. The American Conference of Governmental Industrial Hygienists Threshold Limit Value-Time Weighted Average values were not exceeded during our monitoring. Face washes contained from 185 to 713 ug malathion, 72 - 122 ug malathion

oxon, and 52,150 to 117,540 ug sulfur. Hand washes contained from 1,890 to 2,301 ug malathion, 529 to 659 ug malathion oxon and 306,020 to 557,240 ug sulfur. As with the air samples, sulfur comprised the greatest percentage of the total sample. The high levels of sulfur present, especially on the face, may be a cause of the eye and skin irritation experienced by the workers.

INTRODUCTION

Date farming presents unusual physical conditions for growers and workers. Date palms grow as high as sixty feet; workers scale them as many as six times a season for pruning, fruit thinning, tying bunches, bagging bunches and harvesting bunches. This study investigates the harvesting aspect of date farming in a palm garden (orchard) where trees averaged between fifteen and twenty feet in height.

The date harvesting process begins with the worker spreading a tarpaulin beneath a harvestable date palm. The harvester climbs via a ladder to the top of the trunk of the date palm where he suspends himself via a special harness. The worker then strips the protective paper from a date bunch and cuts the stalk with a machete. The worker lowers the cut bunch to the tarpaulin on the ground by placing a hook through each date bunch and lowering it by a rope attached to the hook. After finishing a palm, the worker decends from the tree and repeats the process on the nearest palm in the adjacent row, such that two rows are harvested at a time.

After two adjacent trees are harvested and date bunches are lying on tarpaulins, the "shaking" portion of the harvesting process occurs. The workers carries each date bunch to a large bin and shakes the dates from the bunch by beating it on the sides of the bin or against other dates in the bin. After the bunches have been shaken into the bin, the worker gathers the tarpaulins from around each trunk and dumps the remaining dates into the bin. The worker then moves the bin with a pickup truck to the next pair of trees, spreads the tarpaulins and begins again.

During the 1987 date harvest season, the Worker Health and Safety Branch received a request from California Rural Legal Assistance (CRLA) to investigate complaints from date harvesters in the Coachella Valley. Workers were concerned that systemic effects such as mild nausea, as well as eye and skin irritation, were being caused by exposure to pesticides in the dust generated by harvest activities. Malathion and sulfur are the only pesticides used on dates.

Preliminary data from a pilot study of worker exposure during malathion applications suggested airborne dust levels could exceed the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value-Time Weighted Average (TLV-TWA) value of 10 milligrams/cubic meter (mg/m^3) for nuisance dust levels. Based on this knowledge the sampling strategy to investigate the harvesters' work environment included a measurement of total and respirable airborne dust levels as well as malathion, malathion oxon, and sulfur adsorbed to the dust. Face and hand washes were done at the end of each monitoring period to determine the amount and composition of the dust on these surfaces. This information provided an estimate of what dust was available to cause or contribute to the reported eye irritation.

MATERIALS AND METHODS

Monitored workers were individually able to fill from six to eight bins a day. Bins are wooden boxes, four feet square, by two feet high. Each bin holds about 800 pounds of dates. Three to five palms were required to fill one bin and each palm yields from nine to twelve bunches of dates. On average, the workers were able to scale a palm, harvest it and return to the ground in a span of five minutes. On the first day, workers filled three to four bins during the observation and monitoring of the last half of their work day. On the second day, workers worked as two-man teams and filled approximately twice the number of bins for the first half of the work day.

Sample Collections:

Monitoring in this study included collecting breathing zone (BZ) air samples, face washes and hand washes.

Air sampling was done using two MSA Fixt Flo^{R} Model One personal air sampling pumps affixed to the worker's belt in the small of his back. One sampling train employed a MSA Gravimetric Dust Sampler Model G cyclone attached a filter cassette which held an SKC glass fiber filter, type AE, and support pad. Approximately 60 centimeters of Tygon^{R} 1/4 inch tubing was used to connect the pump to the sampling device positioned in the BZ. The purpose of this type of sampling train was to collect the fraction of total dust that comprised respirable particles only. "Respirable" particles are those ranging from 1/3 to 10 micrometers in diameter that are selectively passed by the cyclone size-selector and captured by the collecting filter. All particles larger than ten micrometers are captured and retained by the cyclone.

The second air sampling system employed a standard filter cassette with a SKC glass fiber filter, type AE, backup pad and Tygon^{R} tubing, also 60 centimeters in length. The purpose of this air sampling system was to collect a total particulate dust sample from the worker's BZ. The cyclone pump was set at 1.7 liters/minute while the filter-only pump ran at 2.0 liters/minute.

Air samples were collected during the date shaking process only. By observation, the greatest amount of visible dust exposure occurred when the worker stood over the bin and shook the date bunches. In addition, considerations of the sampling equipment posing a potential safety hazard during tree-climbing limited monitoring to ground operations. On day one, each worker conducted all the harvesting tasks alone. The air pumps were attached to each worker only while working on the ground, and were turned off and removed from him when he climbed the trees to harvest bunches. On day two, workers formed two-man teams, with one person cutting and lowering the bunches, while the other person shook the date bunches and performed associated ground tasks. The pumps were allowed to run continuously on the worker remaining on the ground.

Handwashes were collected at the end of monitoring each day. Approximately 450 milliliters (mL) of dioctyl sodium solution (0.1 percent surfactant/water) was poured into a one gallon Ziploc^{R} plastic bag; harvesters washed both hands in this solution for one minute. This

procedure was repeated twice for each harvester. Handwashes were stored in 500 mL amber Nalgene bottles.

Face washes were performed in duplicate and taken immediately after the hand washes. Again, a 0.1 percent surfactant solution was used and each sample was approximately 450 mL in volume. A ten inch diameter stainless steel bowl was used for the face washing. Each person was asked to splash the wash solution on his face for one minute. Face washes were stored in 500 mL amber Nalgene bottles.

Samples were doubled-bagged in one-gallon Ziploc^{R} bags, placed on dry ice, and shipped to the California Department of Food and Agriculture Chemistry Laboratory in Sacramento, California.

Analytical methods:

Malathion, malathion oxon, and sulfur were co-extracted from the glass fiber filters and handwashes.

Glass fiber filters:

Tared filters were weighed for total dust prior to desorption. Filters were desorbed with iso-octane. Malathion and malathion oxon levels were determined using NIOSH method 5012, Vol. III. The sample aliquots were injected into a Hewlett Packard 5880 gas chromatograph with an NPD detector. Recovery was 76 percent at the 30 ug/filter spike level after five days of storage, and 100 percent if the samples were desorbed soon after sampling. Sulfur levels were determined by injecting sample aliquots into a gas chromatograph with an EC detector. Retention time was two-three minutes.

Handwashes:

An aliquot of each handwash was extracted three times with ethyl acetate. Sodium sulfate was added. The three extracts were combined, concentrated or diluted as necessary, and analyzed using gas chromatographs and detectors described above.

RESULTS

Face washes contained from 185 to 713 ug malathion, 72 to 122 ug malathion oxon, and 52,150 to 117,540 ug sulfur (Table 1). Hand washes contained from 1,890 to 2,301 ug malathion, 529 to 659 ug malathion oxon, and 306,020 to 557,240 ug sulfur.

Total dust samples ranged from ND to 1.96 mg/m^3 in the respirable particle sample, and from 6.50 to 36.99 mg/m^3 in the total particulate sample (Table 2). Malathion was present in small amount in the BZ samples, ND to 0.04 mg/m^3 in the respirable particle sample and 0.05 to 0.24 mg/m^3 in the total particulate sample. Malathion oxon levels ranged from ND to 0.01 mg/m^3 in the respirable sample, and from ND to 0.04 mg/m^3 in the total sample. Sulfur levels ranged from 0.29 to 2.20 mg/m^3 in the respirable sample, and from 5.65 to 24.98 mg/m^3 in the total sample.

Values from Table 2 are based on observation and monitoring of two partial work days. On day one, no sampling was conducted during the first half of the workday. One day two, work was concluded at the end of the first half of the day. Results from each half day of monitoring were extrapolated to estimate a typical full work day and to compare the results with occupational health standards.

DISCUSSION AND CONCLUSIONS

Although the primary reasons for conducting this study were eye and skin irritation complaints, the investigators included air sampling to better characterize the date harvesters' work environment. Excessive concentrations of nuisance dusts in the workplace air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages, or cause injury to the skin or mucous membranes by chemical or mechanical action or by the rigorous skin cleansing procedures necessary for their removal (ACGIH, 1986).

ACGIH has established TLV-TWA values, which are time-weighted average concentrations for a normal eight-hour workday and a 40-hour work week, to which all workers may be repeatedly exposed on a daily basis without adverse effect. The threshold limit for total nuisance dust is 10 mg/m^3. The TLV-TWA value for malathion is 10 mg/m^3, with no value set for the malathion oxon. Maloxon is about ten times more toxic than malathion, and 1,000-10,000 times more potent as a cholinesterase inhibitor in vitro (Murphy, 1972). The TLV-TWA for sulfur, considered a nuisance particulate, is also 10 mg/m^3. Nuisance dust and sulfur particles in the respirable size range have a TLV-TWA value of 5 mg/m^3. The ACGIH values were not exceeded during the work place monitoring.

Face and hand washes all contained detectable amounts of sulfur, malathion, and malathion oxon; sulfur was present at much higher levels than malathion or malathion oxon. The high levels of sulfur present, especially on the face, may be a cause of the eye and skin irritation experienced by the workers.

REFERENCES

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Table 1

Date Harvester Exposure Data

Day	Worker	Chemical	Particulate (ug) Measured as Respirable	Particulate (ug) Measured as Total	Hand Wash (ug)	Face Wash (ug)
1	1	Total dust	200	4400	-	-
		Malathion	2.8	29.0	2270.9	364.0
		Oxon	0.3	4.4	644.5	122.0
		Sulfur	225.3	2971.2	306020	52150
	2	Total dust	ND	900	-	-
		Malathion	5.5	5.5	1917.3	185.1
		Oxon	0.8	0.8	658.8	76.0
		Sulfur	46.4	860.1	557240	52580
	3	Total dust	200	2700	-	-
		Malathion	1.6	10.8	1889.8	328.3
		Oxon	0.2	2.1	552.4	72.1
		Sulfur	114.5	2490	399200	78850
2	1	Total Dust	200	2000	-	-
		Malathion	1.1	11.8	697.8	113.2
		Oxon	0.0	1.5	287.3	19.1
		Sulfur	58.7	2101	259500	13641
	2	Total Dust	ND	1600	-	-
		Malathion	1.9	11.7	2006.5	712.8
		Oxon	0.1	1.0	528.9	103.8
		Sulfur	58.6	1390	482684	117540

Table 2

Potential Inhalation Exposure Values

Day	Worker	Chemical	Minutes[a] Monitored	Particulate (mg/m^3) Measured as Respirable	Particulate (mg/m^3) Measured as Total	Eight Hour TWA (mg/m^3) Estimated Value Measured as Respirable	Eight Hour TWA (mg/m^3) Estimated Value Measured as Total
1	1	Total dust	61	1.96	36.99	0.49	9.40
		Malathion	61	0.03	0.24	0.01	0.06
		Oxon	61	0.00	0.04	0.00	0.01
		Sulfur	61	2.20	24.98	0.56	6.35
	2	Total dust	27	ND	17.09	-	1.92
		Malathion	27	0.12	0.10	0.01	0.01
		Oxon	27	0.02	0.01	0.00	0.00
		Sulfur	27	1.03	16.34	0.12	1.84
	3	Total dust	56	2.23	24.72	0.52	5.77
		Malathion	56	0.02	0.10	0.00	0.02
		Oxon	56	0.00	0.02	0.00	0.00
		Sulfur	56	1.28	22.80	0.30	5.32
2	1	Total Dust	115	1.02	8.81	0.49	4.22
		Malathion	115	0.01	0.05	0.00	0.02
		Oxon	115	0.00	0.01	0.00	0.00
		Sulfur	115	0.30	9.25	0.14	4.43
	2	Total Dust	120	ND	6.50	-	3.25
		Malathion	120	0.01	0.05	0.00	0.02
		Oxon	120	0.00	0.00	0.00	0.00
		Sulfur	120	0.29	5.65	0.14	2.82

	Estimated Average 8-hr TWA Values (mg/m^3) Respirable	Total
Total Dust	0.30 ± 0.27	4.91 ± 2.87
Malathion	0.00 ± 0.00	0.03 ± 0.02
Oxon	0.00 ± 0.00	0.00 ± 0.00
Sulfur	0.25 ± 0.19	4.15 ± 1.83

[a] Day one workers were monitored for 117 minutes total. The times shown are the total accumulated times the air pumps operated during the shaking process. On Day Two, the two workers monitored performed only ground activities and two other workers did the climbing, cutting and lowering of the fronds to the ground.